16.400/453

Displays

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Lecture 7

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Overview

- Taxonomy of displays
- Classic display issues
- Design and evaluation of flight deck displays
  - EFB discussion
- Display examples from different domains
- EVS/HUD video

Basic Taxonomy

- Displays can be visual, auditory, haptic etc.
  - Any way to transmit information
  - Focus on visual displays for this lecture
- Static displays
  - Symbols (e.g., road signs)
  - Good for spatial information (e.g., paper maps)
- Dynamic displays
  - Present temporal information such as current status, trends, predictions

Some Classic Display Issues

- Inside-out vs. Outside-in
- Display arrangement
- Moving pointer vs. moving scale display
- Information integration on glass displays

Inside-out vs. Outside-in

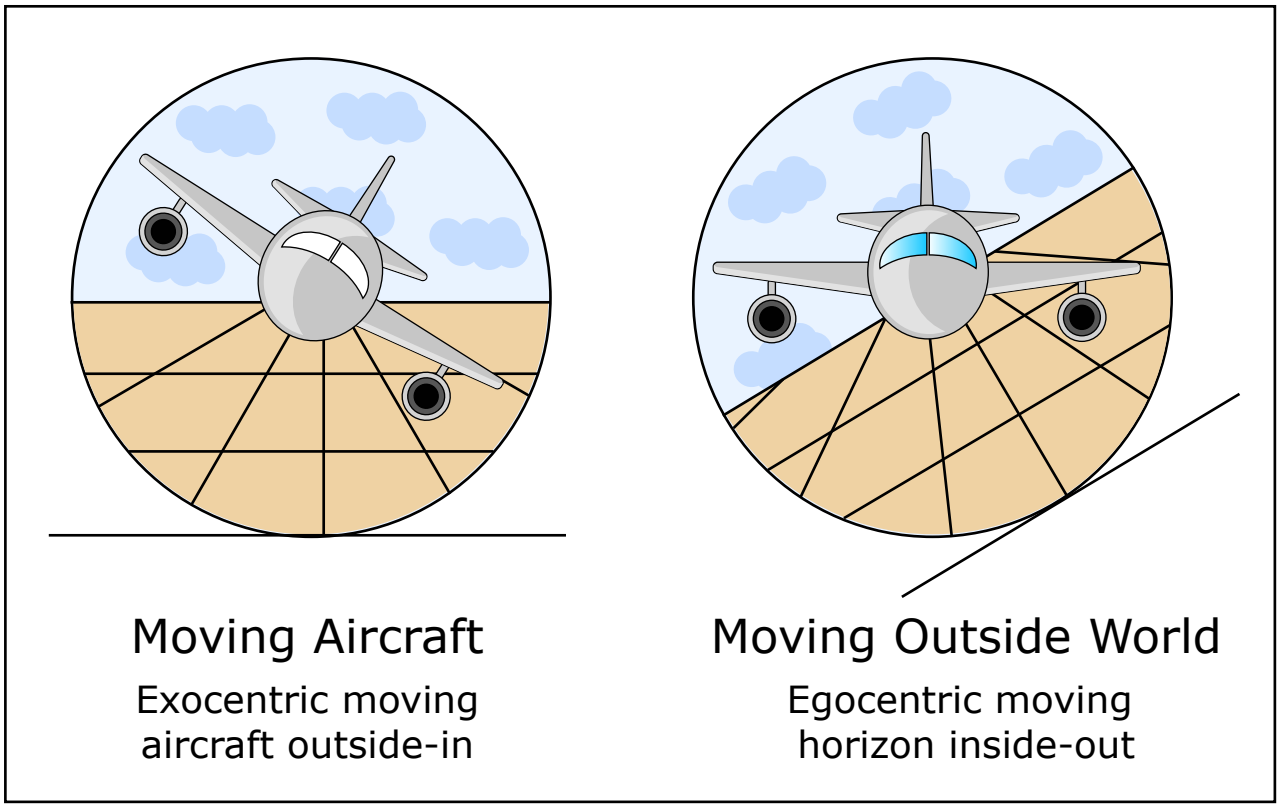

Image by MIT OpenCourseWare.

Display Design

Slides covering the following topics have been removed due to copyright restrictions:

- Early Display Design: Enabling T Scan
- Primary Flight Displays
- Visual Displays: Old vs. New
- Integral Boeing Displays

The Rise of Glass Cockpits

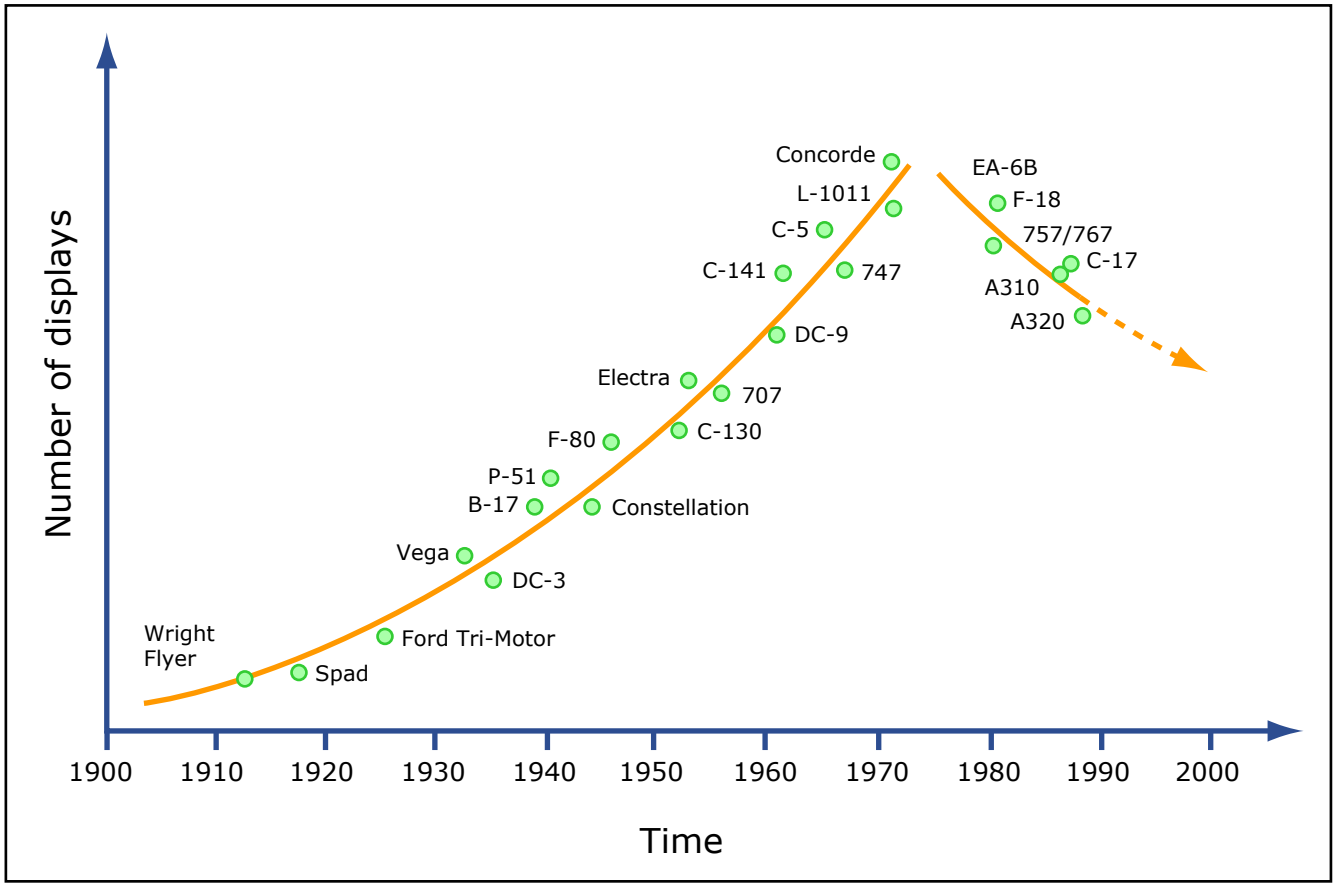

Image by MIT OpenCourseWare.

Boeing 787 Flight Deck

Image courtesy of Jetstar Airways on Flickr.

Display Taxonomy Continued

- Round-dial vs. glass displays
  - A.k.a. electro-mechanical vs. electronic
  - Round-dials are often separated while glass displays are typically integrated
- Analog vs. digital
  - e.g., car speedometers show either a needle & dial or numbers
- Shared displays
  - Glass displays with multiple functions that are either overlaid (e.g., traffic & weather) or switched between (display modes)

Visual Display Design Considerations

- Display size
- Density
- Screen Resolution
- Clutter
- Color
- Luminance
- Brightness
- Font Size
- Field of View
- Highlighting
- Grouping
- Vibrations
- Dark adaptation
- Analog vs. Digital
- Dual Coding
- Graphical vs. Textual representation of data

General Display Implementation Issues

- Design
  - Display size
  - Presentation of information
  - Interaction
  - Location relative to operator
- Evaluation
  - By regulators, users, purchasers…
- Standardization

Electronic Flight Bag

- Combination of hardware and software
  - Some general purpose devices (iPad), some aviation-specific (Astronautics)
  - Portable or installed or mounted in flight deck
- Report on EFB human factors considerations (2003) used by FAA and other authorities to evaluate EFBs

Image of electronic flight bag removed due to copyright restrictions.

Display Design and Evaluation

- General issues
  - Legibility of fonts and labels, training, ease of use, “intuitiveness”
- Hardware
  - Screen size
  - Physical controls and interaction
  - Screen technology (e.g., CRT, LCD, HUD)
    - Resolution, refresh rate, viewing angle, brightness (daylight readability)
    - Input devices, e.g., touch screen, cursor control device
- Software
  - Software controls (e.g., buttons, icons)
  - Color
  - Multi-tasking and interaction
    - Data entry, configuration
  - Information time lag (e.g., traffic)
- Design standards
  - RTCA DO-160 Environmental Testing
  - RTCA DO 178-B software assurance

Examples

- Aeronautical chart samples
- Flight deck traffic displays
- Boeing 787 flight deck slides
- Air Traffic Control Displays
- Weather Displays
- Automobiles
- Locomotives
- Enhanced Vision Systems and Head-up Displays

Traffic Alert and Collision Avoidance System (TCAS) Traffic Display

This image is in the public domain. Source: Wikipedia.

Standard TCAS symbology

Image of TCAS display removed due to copyright restrictions.

- TCAS traffic display shows
  - Traffic Alerts (TAs)
  - Resolution Advisories (RAs)
  - Proximate traffic as either or
  - Relative altitude and climb/descent information

Newer Traffic Displays

Image of Garmin G1000 CDTI Display removed due to copyright restrictions.

- New symbols can present more information
  - e.g., data quality, directionality
- How much information can be encoded visually in a traffic symbol without confusing the pilot?

Air Traffic Control

- Issues include
  - Information integration, time lag, ambient lighting

Image of New York TRACON removed due to copyright restrictions.

Image of Newark Tower interior removed due to copyright restrictions.

Integrated Terminal Weather System

- Issues include
  - Information integration, both spatial and temporal

Image of ITWS interface removed due to copyright restrictions.

Locomotive Displays

- Beginning to convert to glass displays
  - Standardization
  - Display arrangement
  - Information integration

Human Factors in Display Advertisements…

- Garmin multi-function displays for general aviation

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